

Electric City

Copenhagen

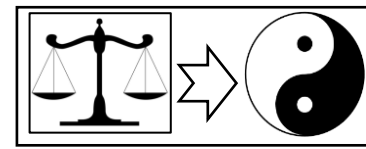
Daniel Mortensen (DMORT)

25 NOV 2021

Ørsted



Introduction and background



Orsted

Offshore Wind Energy - Scenario

Our offshore footprint

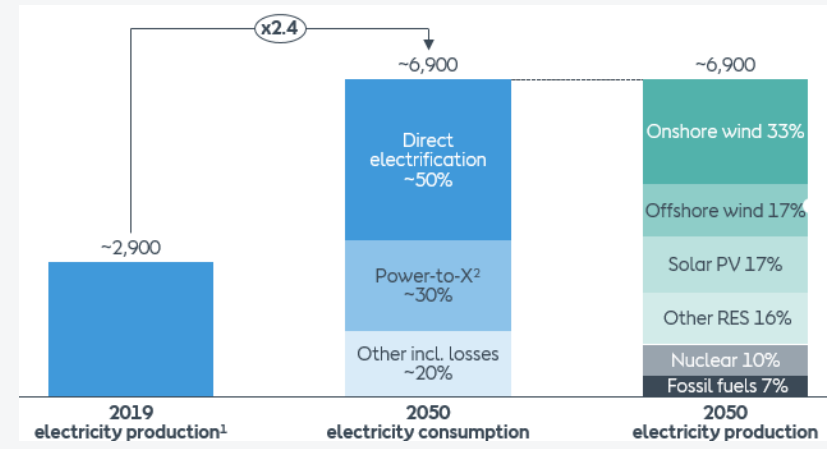
30 years of experience and track record in the offshore wind power sector

27 offshore wind farms in operation

2 under construction

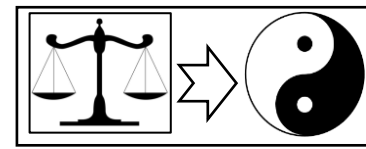


Projected EU electricity consumption and production to reach net-zero by 2050



- TWh, EU-27
- GW Caapcity app. 4TWH
- 2050: +300GW

Introduction and background



Energy Islands

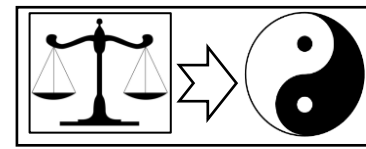
- Power Transformation / Conversion / Distribution
- Hydrogen Production
- Power Storage / Production (no-wind)



Interconnection and Distribution

- Utilization of Transmission Systems (Power/Hydrogen)
- Interconnecting Regions





Defence & Offshore Wind



- Introduction

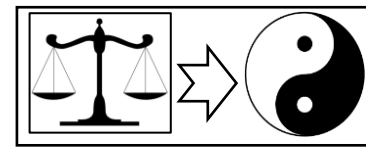
- ➔ • Strategic Landscape

- Offshore Trials

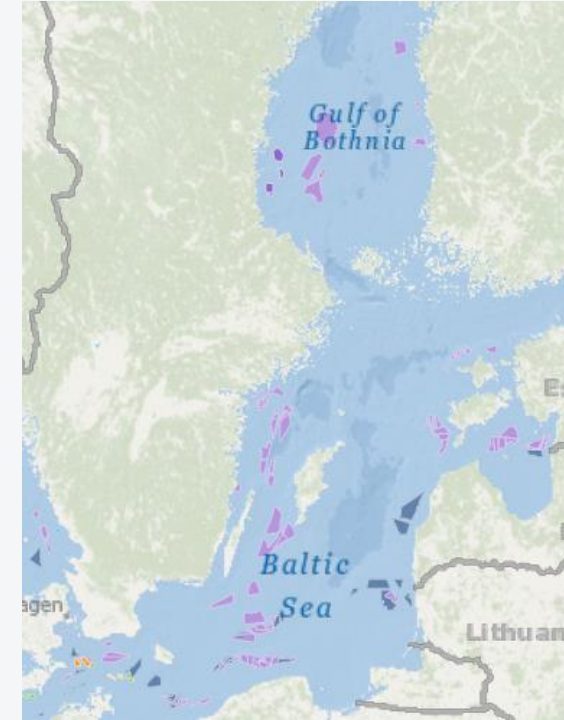
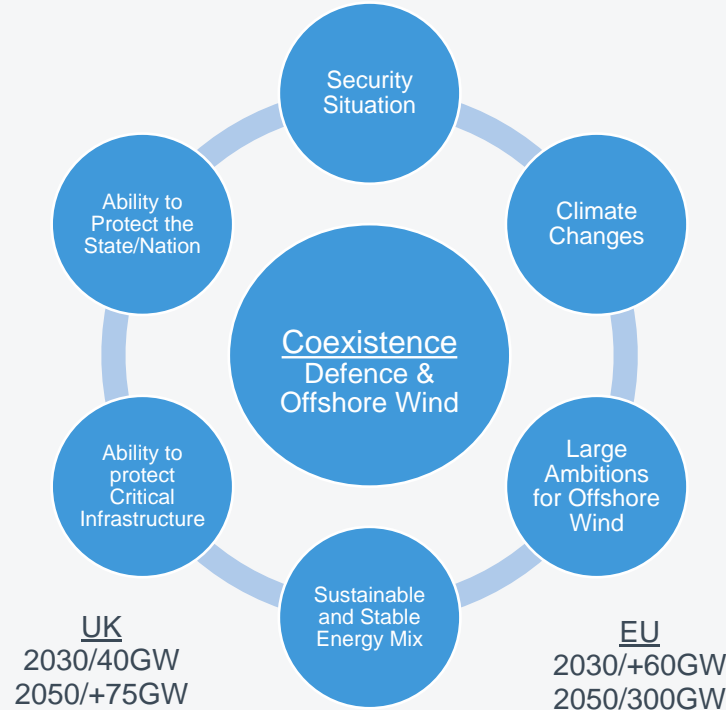
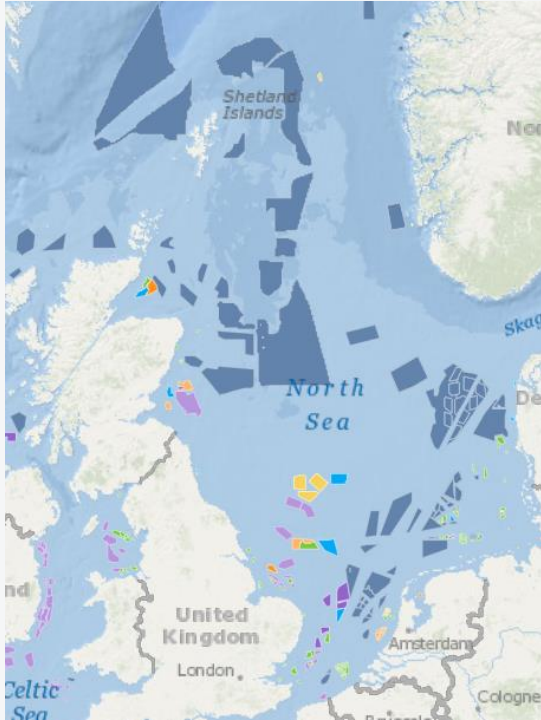
- Offshore Concept



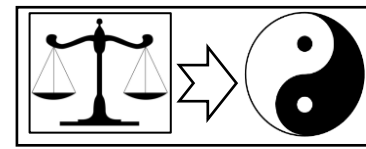
Strategic Landscape



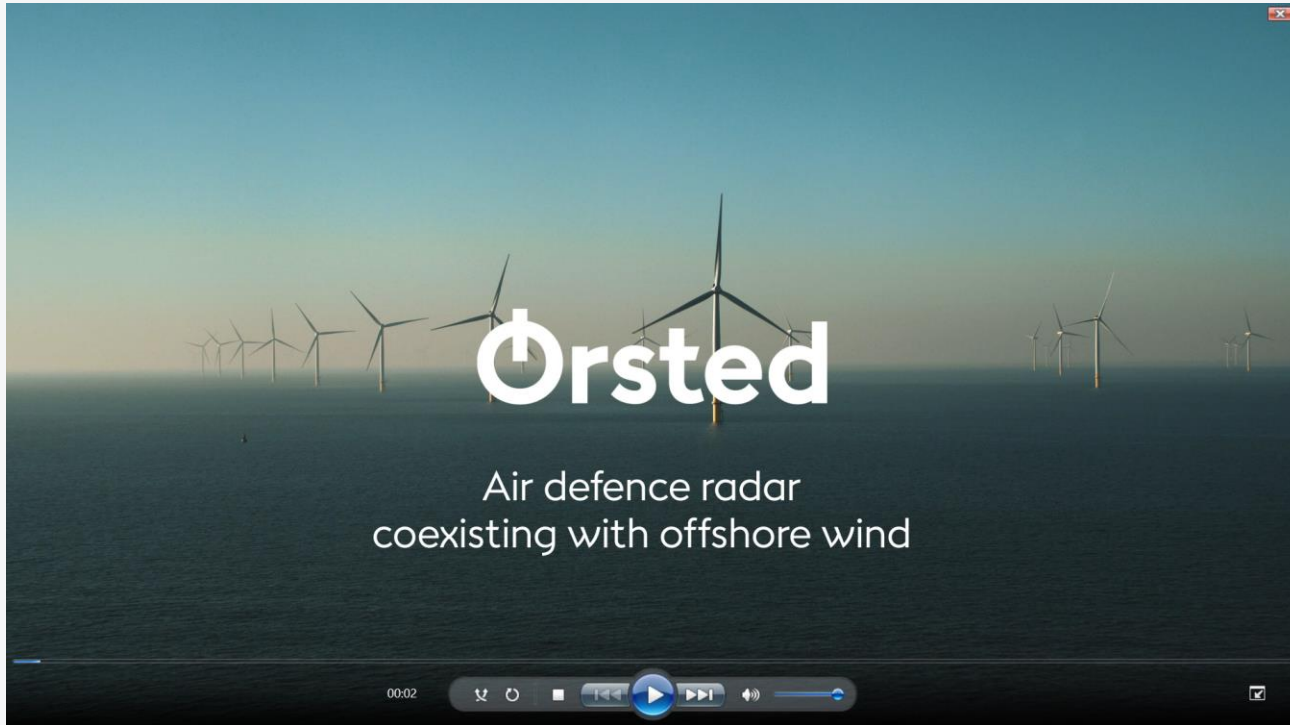
Landscape Components



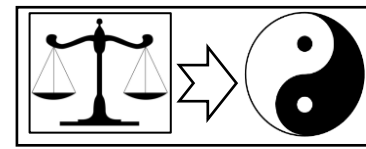
Orsted General Introduction



Air Defence Mitigation



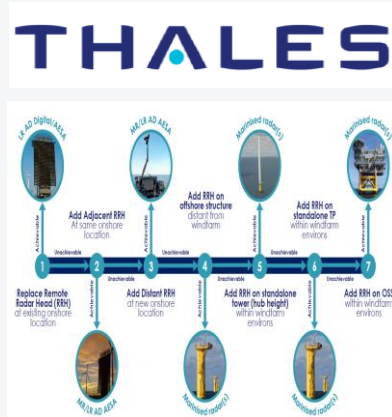
Offshore Trials Rationale



The History Line

Ørsted Internal MDMP to MSN "Coexistence"

Comparison Criteria (Impact)	Rationale & explanation	WT Level of significance	COA #1 Offshore replace	COA #3 Offshore Hybrid	COA #4 Offshore Hybrid	COA #5 Offshore Hybrid	COA #6 Offshore WTC	COA #8 Yacht Radar	COA #9 Offshore TP	COA #10 Offshore Floating
Overall Performance										
Effectiveness	How well does the Study solve the task and mitigate the OIAP interference. Does the concept deliver full capability of the OIAP cover area/other advanced RH/LOS	3	3	3	3	3	3	3	3	3
Supplementary capacity	Physical site security and access control: Fence/Water force. Threat both digitally and physically interference	2	0	0	0	1	2	2	2	2
Protection of radar head	Threat to radar head	1	3	3	3	1	1	2	2	2
Protection of data integrity	Threat to data integrity	3	3	3	3	3	3	3	3	3
Implementation Complexity	How feasible is the system when implemented. Is it scalable and can be reconfigured for further OIAPs in area - no X, based on site with appropriate requirements.	2	1	2	2	4	3	4	2	4
Performance Feasibility/Quality		1	2	2	1	1	2	2	3	3
OHM										
Responsibility of asset	Needs definition and requires clarification - who owns the asset in mixed responsibility or 100% SA? Inherently 100% RAF owned + Good Shared ownership + Moderate	1	3	3	3	3	2	2	2	2
Operational Complexity	Complex to operate - Good High technical complexity demands high training requirements. Low technical complexity demands little or none extra training.	3	1	3	2	6	2	6	1	3
System Availability	Overall system availability and robustness of surveillance capability	2	3	6	3	6	3	6	1	2
Maintenance Complexity	Combination of required/maintenance and repair in relation to accessibility and system complexity in 3D. Risk to repair changed - 2D water work onshore repair High technical complexity demands high training requirements. Low technical complexity demands little or none extra training.	2	1	2	3	6	3	6	2	1
Economy - Low cost good high cost/bad										
Cost Development	Technology, Procedure, Organisation	3	1	3	2	6	2	6	3	9
Cost Implementation	Technology, Procedure, Organisation	1	1	1	1	1	1	1	1	1
Cost Operations & Maintenance	Technology, Procedure, Organisation	2	3	6	2	4	2	4	3	6
Implement										
RH location consent	Frequency allocation Electromagnetic emission EM	2	3	6	2	4	1	2	2	4
RH Access to Utility	Power HVAC SCADA Surveillance/Control Surveillance/Control Fire detection and suppression	1	3	3	3	3	2	2	3	3
RH Foundation	Perimeter surveillance Structure	1	3	3	3	3	2	2	3	3
RH Support facilities	Access control	1	3	3	3	2	2	3	3	3
RH Data Network	Cabled wired network Secured wireless network (4G/5G/WiFi) or satellite Public or private fiber Hub/bleed or single string communication from RH to shore based redundancy	2	3	6	3	6	3	6	2	4
INCLCIS issue	The United Nations Convention on the Law of the Sea (UNCLOS), also called the Law of the Sea Treaty, Convention or the Law of the Sea Treaty.	2	3	6	3	6	3	6	1	2
Risk										
Performance Risk	What is the risk to main system components	3	3	3	3	3	3	3	3	3
- Risk to utility support		2	3	6	3	6	1	2	3	6
- Risk to data integrity		3	3	3	3	3	3	3	3	3
- Risk to RH support		1	3	3	3	3	2	2	3	3
Totals		55	103	89	117	50	98	82	95	60
Legend: 3-High, 2-Moderate, 1-Lowest										



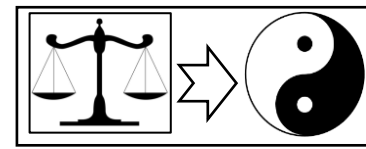
UK Joint TF



Industry



Offshore Trials Rationale



Trailed Systems



Aim

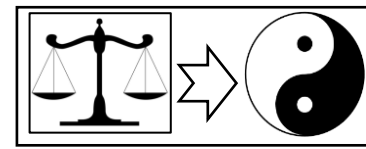
Investigate availability of COTS/MOTS TRL8-9 short range and high-resolution radar systems as enabling components to the concept of an offshore gap filler solution

Objectives

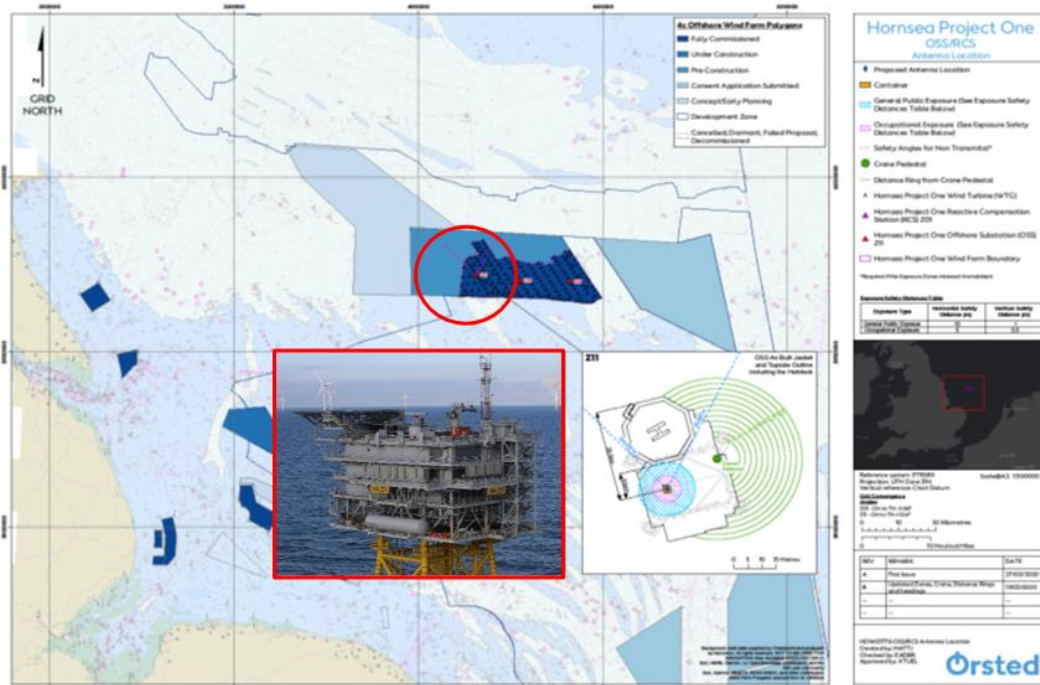
- Support ambition of having a standardized, modular and scalable solution to support coexistence that is compliant with wind farm EPC process
- Trial as close to a 2026- deployment scenario as possible “close uncertainty”
- Investigate performance towards current and possible future scope of surveillance requirements
- Increase awareness and understanding of the opportunity to equip windfarms with relevant surveillance and communication systems



Radar Trials Deep Dive



Environment and test platform



Facts:

The radar is situated **120km** off the UK, Yorkshire Coast.

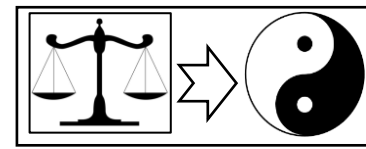
At 1.2GW, the project is the **world's biggest offshore wind farm** and the first to have more than 1GW of capacity and is producing enough energy to power well over one million homes.

Hornsea Project One is constructed on an area of 407km² and is equipped with 174 Siemens wind turbines rated at 7MW each.

Turbines are 190m-tall and have a rotor diameter of 178m with a maximum height of 200m to the blade tip.

- Nacelle height 111m/300ft

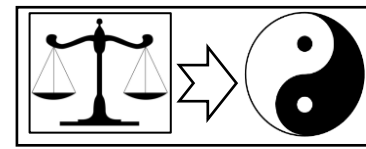
Radar Trials Deep Dive



Environment and test platform



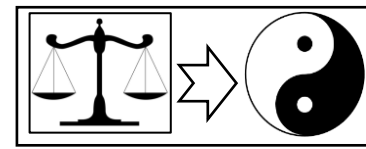
Radar Trials Deep Dive



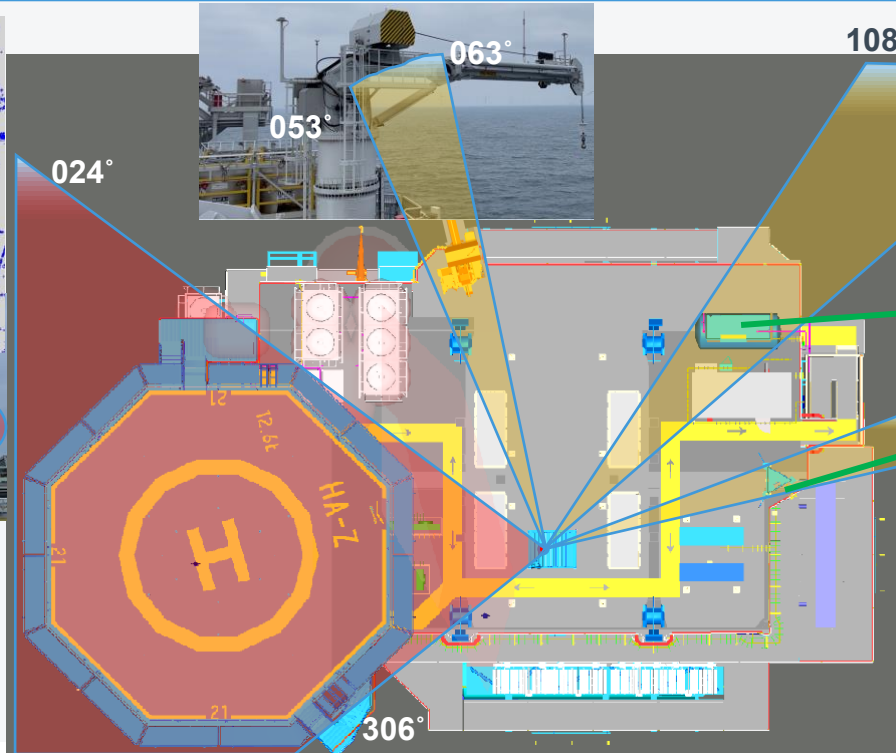
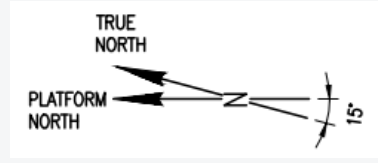
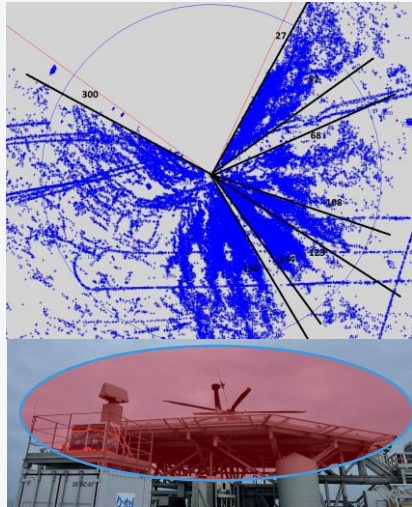
Environment and test platform



Radar Trials Deep Dive



Environment and test platform

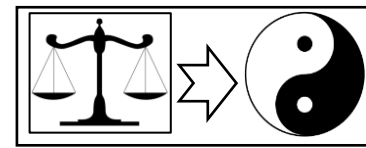


RLOS - Safeguarding
Challenged at the ad hoc deployment
for the purpose of trialing

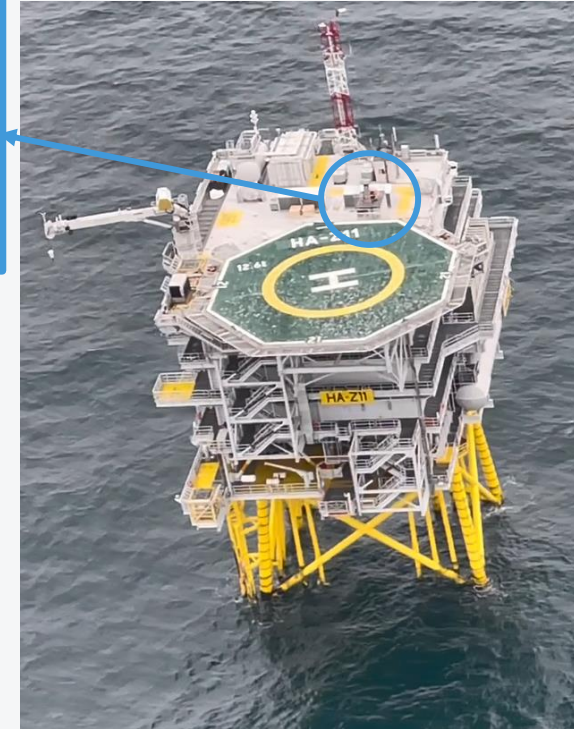
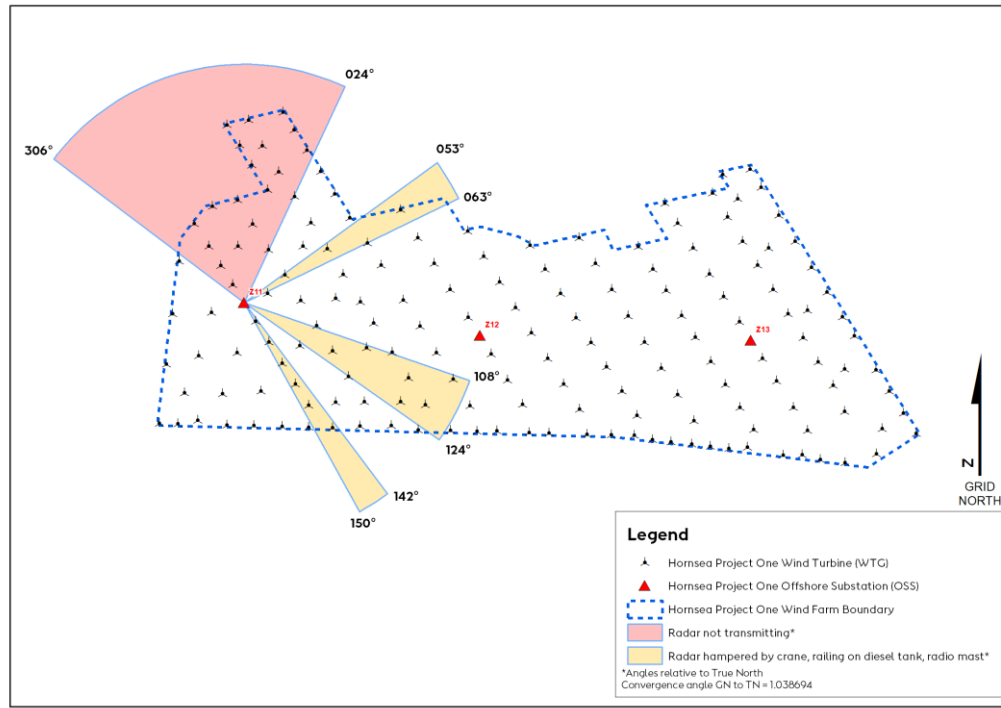


- Legend:**
- Red: Radar not transmitting
 - Orange: Radar hampered by
 - Crane
 - Railing on diesel tank
 - radio mast

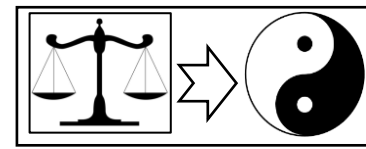
Radar Trials Deep Dive



Environment and test platform

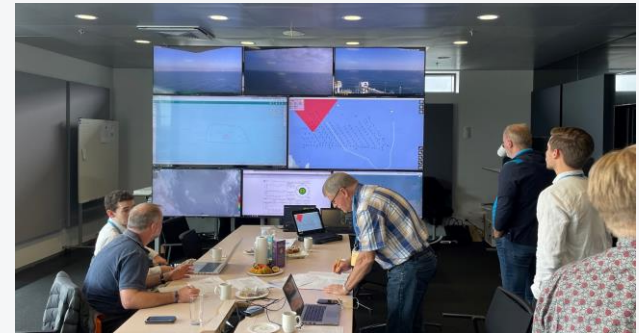
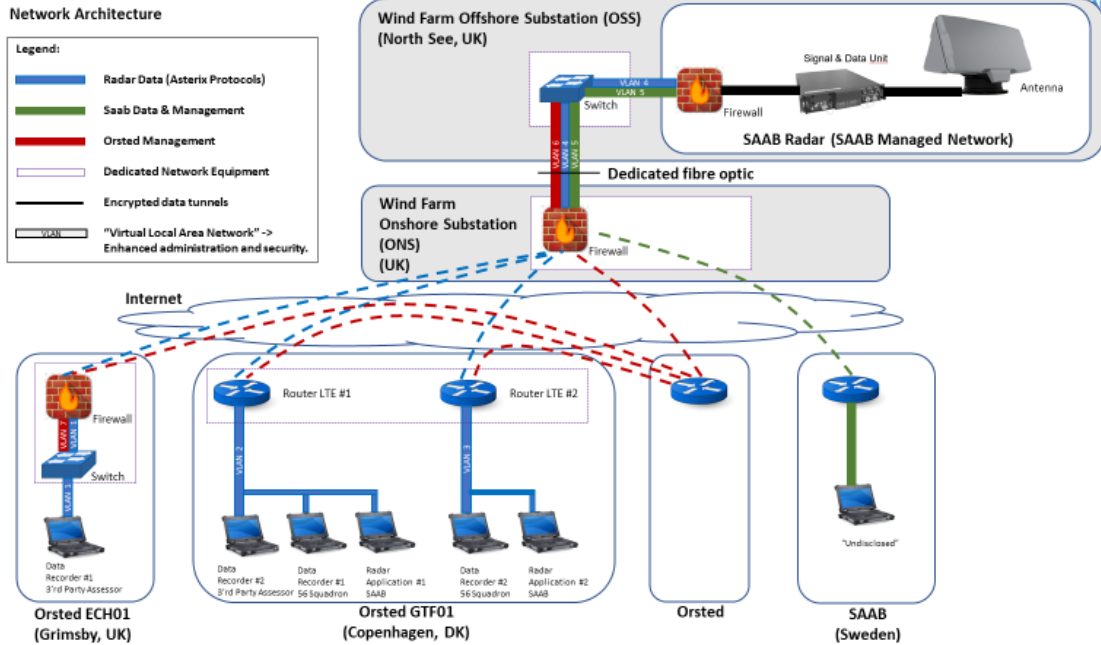


Radar Trials Deep Dive



Environment and test platform

Establishing networks, Recordings, Voice comms



Radar Trials Deep Dive

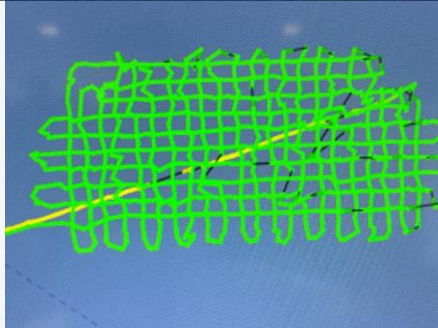


Planned Flight trial weeks:

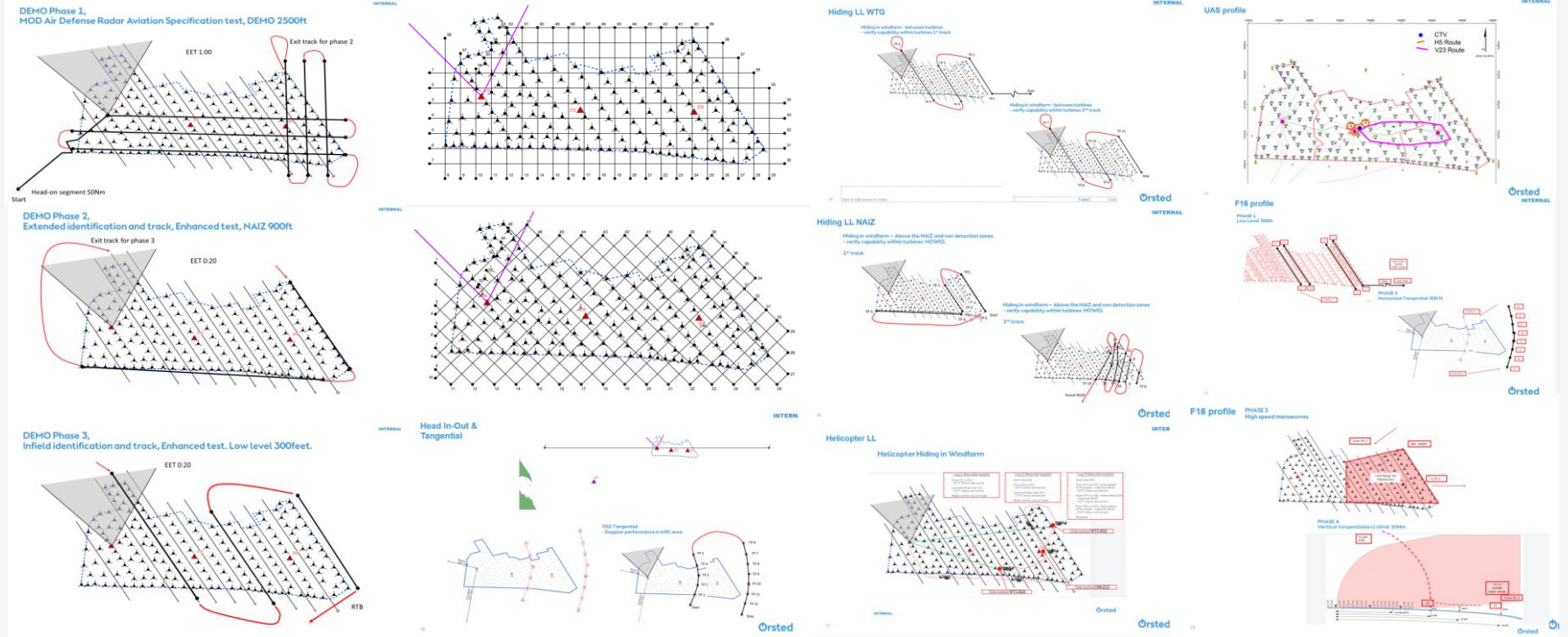
Week 36	Radar calibration flights
Week 37 – 41	Flight test
Week 42 – 42	Backup

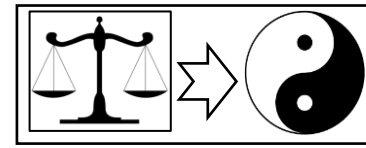
Estimated flight hours and test days:

DA42:	60 hours	8 days
Helicopter:	4 hours	1 day
Fighter jet:	2 hours	1 day



Radar Trials Deep Dive





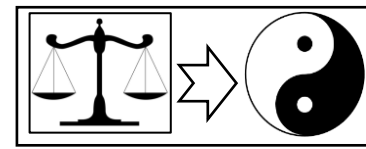
Defence & Offshore Wind



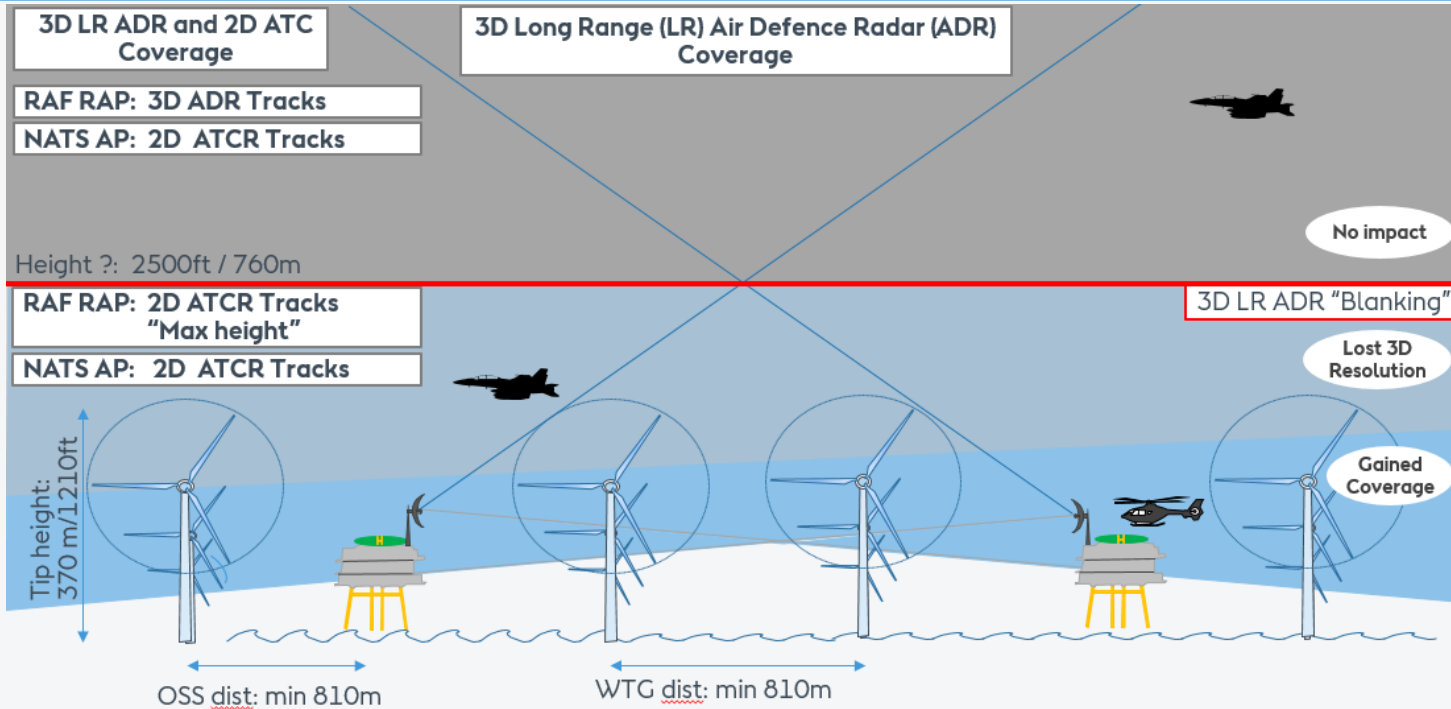
- Introduction
- Strategic Landscape
- Offshore Trials
- ➔ • Offshore Concept



Radar deployment



Offshore 2D Radar Gap Filler Concept



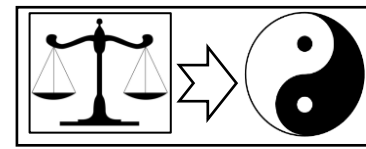
ADR: Air Defence Radar
 AP: Air Picture
 ATC: Air Traffic Control

OSS: Offshore Substation Station
 MOD: Ministry of Defence
 LR: Long Range
 RAP: Recognised Air Picture

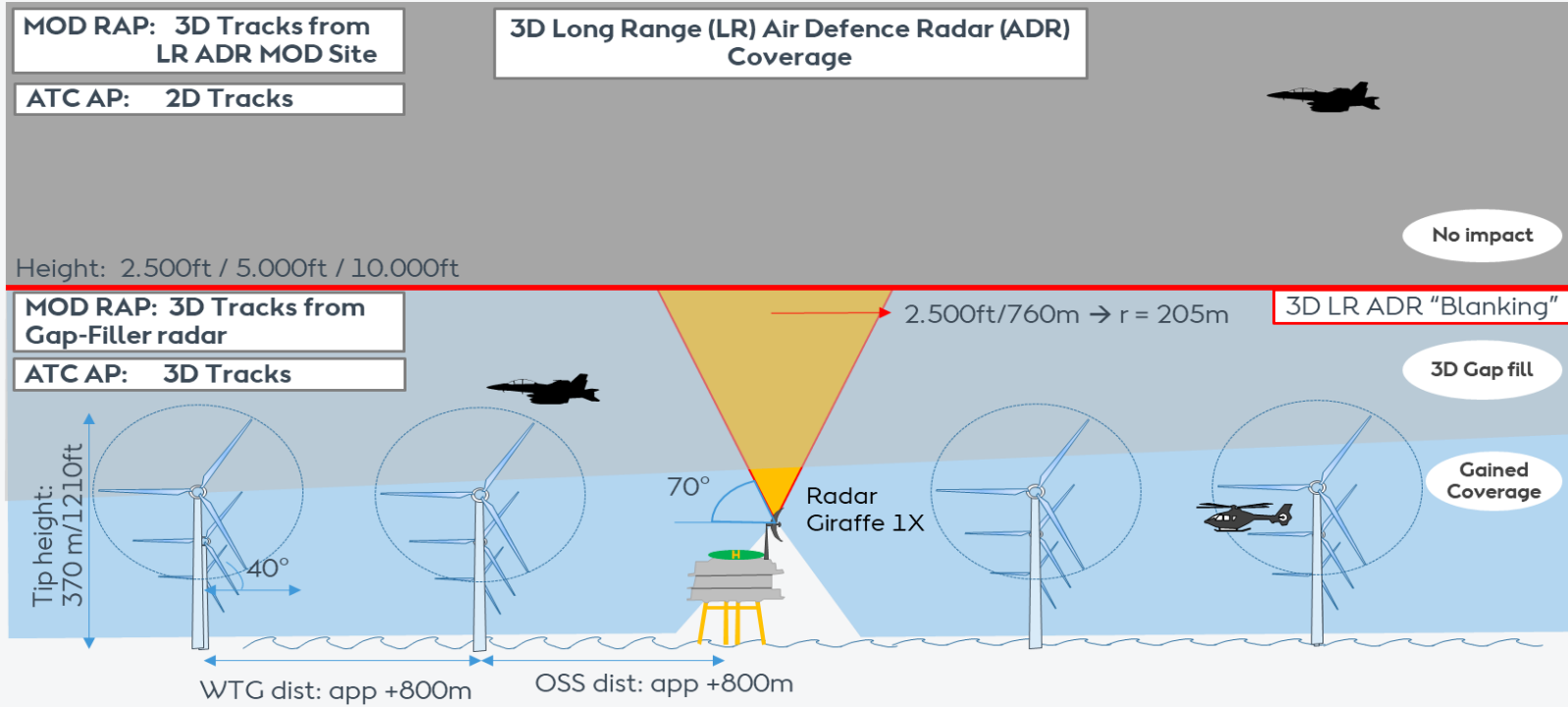
DMORT 25NOV2021



Radar deployment



Offshore 3D Radar Gap Filler Concept

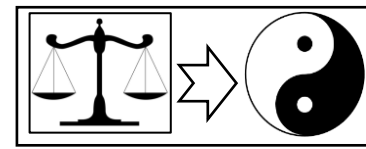


ADR: Air Defence Radar
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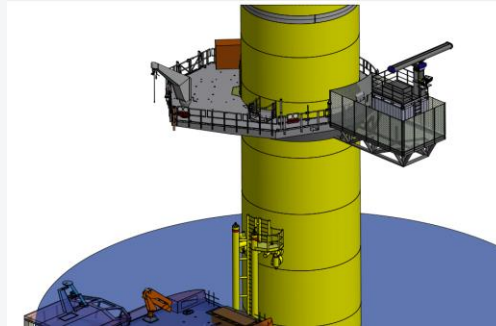




Offshore Military Surveillance and Communication Site

Concept

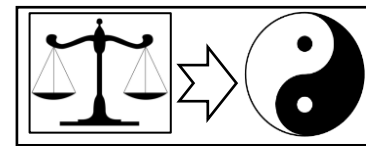
- Standardised site for substations and turbine positions
- Host military classified equipment
- 24/7/365 Perimeter surveillance and access control
- Secure and redundant networks for Mil. Payload and Tech. integrity
- Remotely destruction of sensitive equipment



Concept

- Simple and robust interface towards host structure and auxiliary systems
- Standardised module with customised content and capacity
- Low Mean Time To Repair
- Utilizing host structure and wind farm site logistic set-up

Radar deployment



Offshore Military Surveillance and Communication Site

Sensors, Radar

3D Air Defence



2D Air Traffic Control
2D Surface Radar



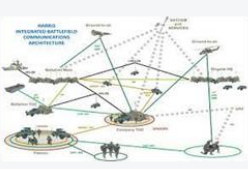
Sensors, Passive



Sensors, Electrooptical



Communication

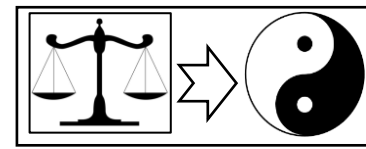


Offshore Site



Military Site

Radar deployment



Offshore Military Surveillance and Communication Site

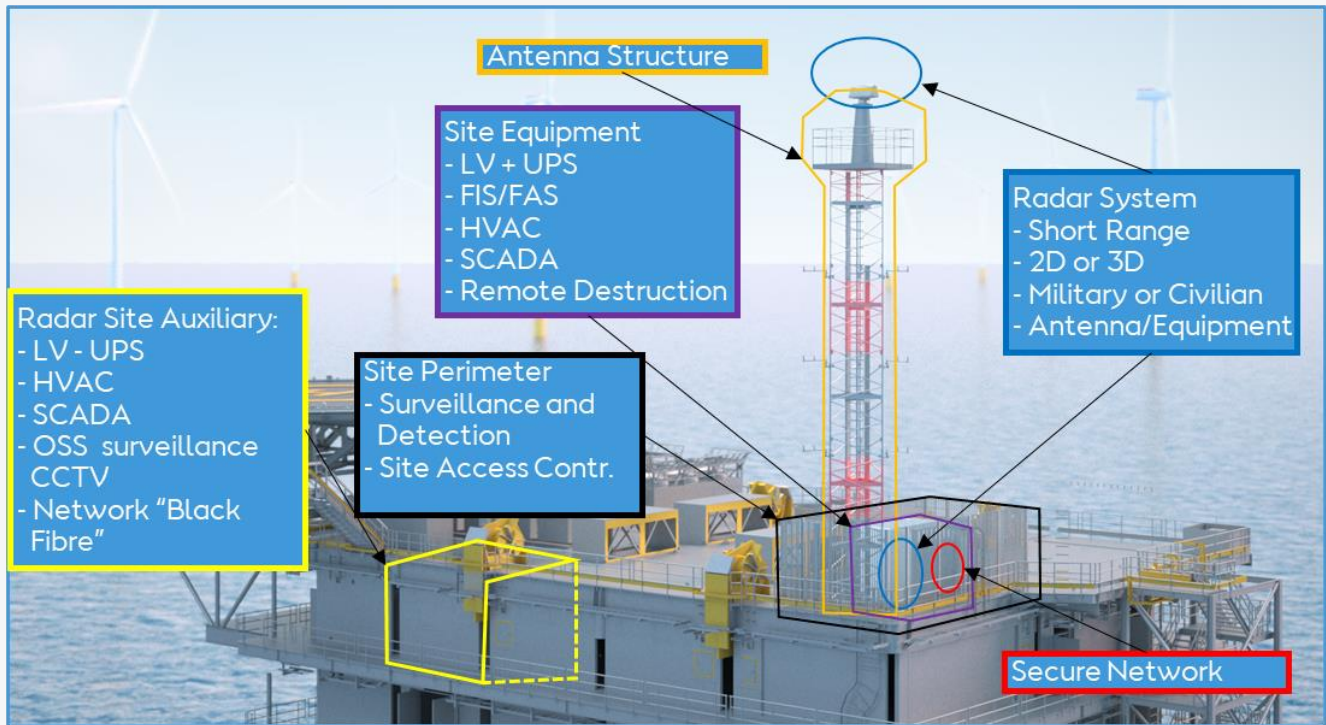
Radar Antenna



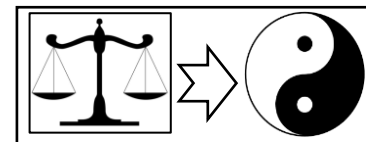
Radar Equipment



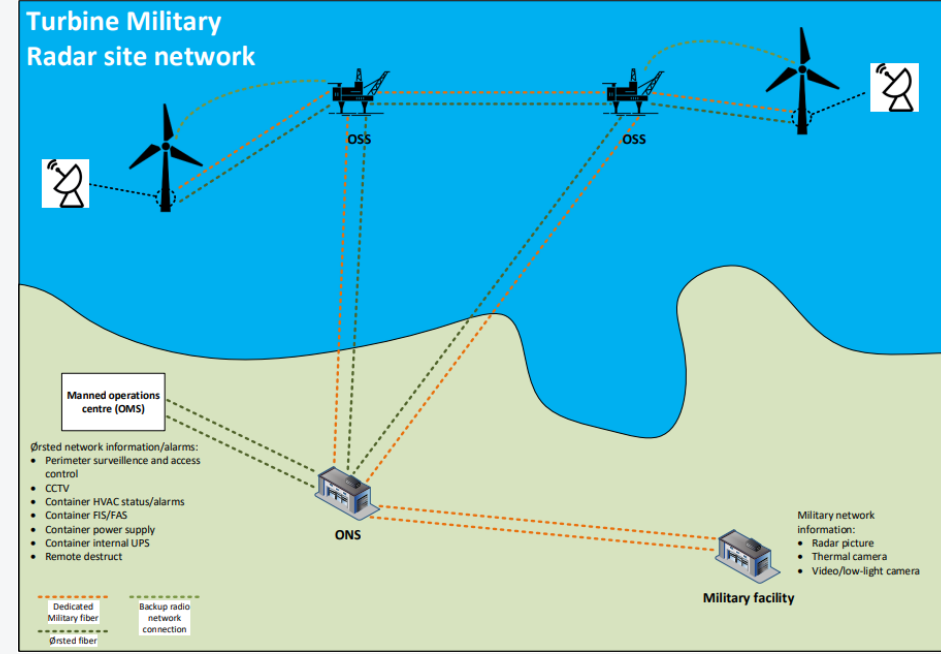
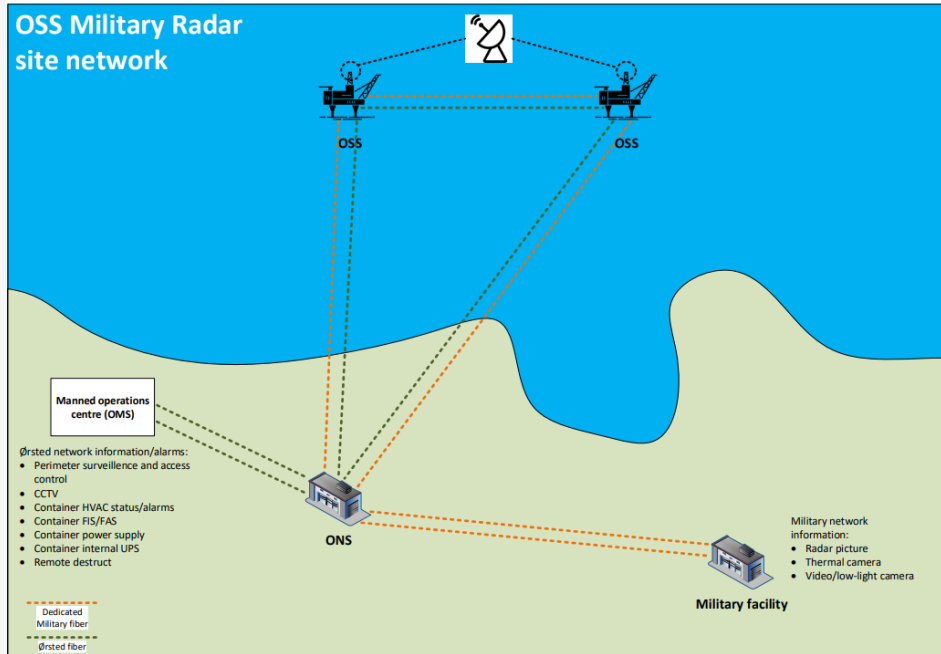
Secure Network Equipment



Radar deployment






























Offshore Military Surveillance and Communication Site



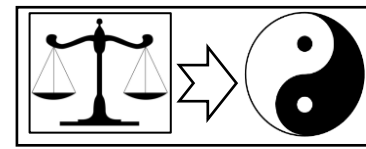
Radar deployment

1st. Circle, progression
2nd Circle, Outlook/Status

 Not started // Unclear status
 Completed // Good status
 Delayed // Concerns
 Late // Issues - Barriers

Requirement	Remarks	Status
Suitable radar system	<ul style="list-style-type: none"> Supply chain: COTS / MOTS TRL8-9 Design: 24/7/365 offshore capable Performance: Strong offshore trial results 	 
Legal	<ul style="list-style-type: none"> Obstructions: Not been possible to identify law against deployment UNCLOS: Conditioned bases for nations to deploy military equipment in EEZ 	 
Permit/Consent	<ul style="list-style-type: none"> Possible changes to windfarm consent/permit envelope (HOW04 ok) Transmission permits 	 
Lease	<ul style="list-style-type: none"> Hosting radar site: TCE is positive, when related to OWF impact – not regional 	 
Divestment	<ul style="list-style-type: none"> Law of Armed Conflict: OWF is a target, but will increase with mil. equipment Possible objection or constrain from Ofgem (to be investigated) 	 
Insurance	<ul style="list-style-type: none"> Law of Armed Conflict: OWF is a target, but will increase with mil. equipment Possible increase to premium (to be investigated) 	 
Safeguarding, Design	<ul style="list-style-type: none"> Deployment of radar/-s that allows for acceptable coverage inside/outside windfarm Location of radar at structure to secure free RLOS and safe RADHAZ 	 
Safeguarding, Lifetime	<ul style="list-style-type: none"> Protecting the radar RLOS from new developments MOD Sub lease: TCE is positive (HOW04) MOD Ownership of site: Possible under OFTO interface agreement 	 
Protecting Sensitive Equipment	<ul style="list-style-type: none"> Perimeter surveillance 24/7/365 (MOD or OWF Ops) Breach resistance site Remotely/automatically destruction of sensitive equipment 	   
Protecting Data Feed and Control	<ul style="list-style-type: none"> Encrypted data link from Site to MOD using black fibre Offshore access control and awareness from site personnel and units Perimeter surveillance 24/7/365 (OWF Ops) 	 
Low Mean Time to Repair	<ul style="list-style-type: none"> Modular design allows for site technicians to “exchange” modules Module exchange performed by organic lifting capacity and site logistic set-up 	 

Further Information



Point Off Contact

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Partners



SAAB

Downloads

- Ørsted Introduction Video
<https://vimeo.com/user7344570/review/574844778/80d75b6ff5>
Password: OffshoreRadarTrial
- 2D Radar Trial HOW01 - F16 Trial Full Version "Final"
<https://vimeo.com/526326625/0c71dbbe58>
- 3D Radar Trial HOW01 - F16 Trial Full Version "Final"
<https://vimeo.com//624417807>
Password: Will be issued upon request